Evaluation of root-end cavity preparation using ultrasonic retrotips

H. Ishikawa, N. Sawada, C. Kobayashi & H. Suda

Pulp Biology and Endodontics, Department of Restorative Sciences, Graduate School, Tokyo Medical and Dental University, Tokyo, Japan

Abstract

Ishikawa H, Sawada N, Kobayashi C , Suda H. Evaluation of root-end cavity preparation using ultrasonic retrotips. *International Endodontic Journal,* **36**, 586–590, 2003.

Aim To evaluate and compare the efficiency of root-end preparations using ultrasonic retrotips coated with diamond and zirconium nitride.

Methodology Eighty-five extracted single-rooted teeth were root filled, and then resected 3 mm from their apices. Root-end cavities were prepared with KiS (zirconium nitride-coated retrotip), CT-5 (stainless steel tip) or diamond-coated (DC) ultrasonic retrotips, and 10 teeth served as controls. Thirty teeth were used for evaluation of the time required to prepare the root-end cavity, the number of microcracks produced on the resected surface and the number of dentinal tubule openings on the root-canal wall using scanning electron microscope (SEM) images. A further 55 teeth were used for evaluation of dye penetration following filling of the root-end cavities with Super EBA. The degree of dye penetration in millimetres was measured under the microscope after 7 days of immersion in India ink. Statistical analyses were performed using the one-way ANOVA and Scheffe's *F*-test as the post hoc test.

Results There was no significant difference in the number of microcracks and dentinal tubule openings present in the root apices prepared by the three retrotips. The time required for root-end cavity preparation using the DC retrotip was significantly less than that using the other groups ($P < 0.01$). Positive controls showed dye penetration throughout the length of the root-end cavity, and negative controls showed no dye penetration. There was no significant difference between the three experimental groups in dye penetration.

Conclusions In this laboratory study, the time required to prepare root-end cavities using KiS retrotips was the same as that using CT-5 retrotips, and longer than that using DC retrotips. There was no significant difference in the number of microcracks or dye penetration between the three kinds of retrotips.

DropBooks

Keywords: dye penetration, microcrack, preparation time, root-end cavity, ultrasonic retrotip.

Received 1 March 2002; accepted 28 February 2003

Introduction

Ultrasonic retrotips have been developed as an alternative to the low-speed handpiece for root-end cavity preparation. Many reports have been written on the properties of ultrasonic retrotips (Gorman *et al.* 1995, Sultan & Pitt Ford 1995, Frank *et al.* 1996, Lloyd *et al.* 1996, Peters *et al.* 2001). With these tips, apical root-end cavity preparations can be carried out perpendicular to the long axis of the root (Gilheany *et al.* 1994), allowing the preparation to follow the direction of the original root canal. However, ultrasonic retrotips have been reported to produce microcracks on the resected surfaces (Abedi *et al.* 1995, Waplington *et al.* 1997). Saunders *et al.* (1994) reported that ultrasonic retrotips produced microcracks, although preparation using the ultrasonic retrotip did not affect the sealing ability of root-end-filling materials.

The purpose of this study was to evaluate three different designs of ultrasonic retrotips in terms of the time required to prepare the root-end cavity, the number of microcracks produced on the resected surface, the

Correspondence: Dr Haruki Ishikawa, Pulp Biology and Endodontics, Department of Restorative Sciences, Graduate School, Tokyo Medical and Dental University, 5–45 Yushima 1-chome, Bunkyo-ku, Tokyo 113-8549, Japan (Tel.: +81 3 5803 5494; fax: +81 3 5803 0197; e-mail: h-ishikawa.endo@tmd.ac.jp).

© 2003 Blackwell Publishing Ltd

amount of dentinal smear accumulation on the root-canal wall and the effect on sealing of the root-end filling.

Materials and methods

The root canals of 85 extracted human maxillary anterior teeth were instrumented with K-files (Zipperer, VDW, Munich, Germany) using the stepback technique, and obturated with gutta-percha (GC, Tokyo, Japan) and sealer (Canals-N®, Showa Yakuhin Kako Co., Tokyo, Japan) using cold lateral condensation. The apical 3 mm of the root was removed perpendicular to the root axis with a fissure bur (No. 2, Dentsply Maillefer, Ballaigues, Switzerland) at 10 000 r.p.m. under water spray cooling.

Experiment 1

The resected apical surfaces of 30 teeth were stained with 1% methylene blue for 30 s, and the numbers of microcracks were counted under a microscope (magnification × 4500, OPMI 111®, Carl Zeiss, Thornwood, NY, USA). Then, the experimental teeth were randomly divided into three groups, and root-end cavities were prepared using either KiS zirconium nitride coated retrotips (Obtura Spartan, Fenton MO, USA), CT-5 retrotips (EIE Analytic Technology, Glendora, CA, USA) or diamond-coated (DC) retrotips (prototype, Osada, Tokyo, Japan) (Fig. 1). CT-5 and KiS retrotips were used with a Spartan® ultrasonic unit (Obtura Spartan, Fenton MO, USA), and DC retrotips were used with an ENAC unit (Osada, Tokyo, Japan). The root-end cavity was prepared in a saline bath at the maximum power of the unit, and the time required to prepare the root-end cavity was recorded. Thereafter, the resected surfaces were again stained with 1% methylene blue for 30 s, and the number of microcracks was counted under a microscope as before.

Each root was longitudinally divided into two halves using a diamond disc. All specimens were dehydrated with alcohol, dried at the critical point, coated with osmium and examined under a scanning electron microscope (SEM) (HITACHI S-4500, Tokyo, Japan). One specimen each in the KiS and DC groups could not be evaluated because the preparation of the specimen was not satisfactory. The number of dentinal tubules opening on the root-canal wall was counted at ×4500 magnification in 10 randomly selected visual fields (19.53 μm × 24.30 μm) to evaluate the presence of smear layer. The criteria for evaluation were standardized by two examiners. The specimens were randomly numbered, and the examiners could not recognize the source of the specimens.

The data were statistically analysed using the one-way ANOVA and Scheffe's *F*-test as the post hoc test.

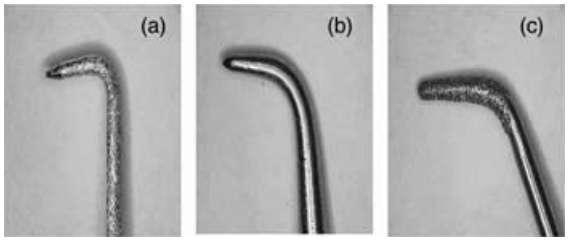

Figure 1 Three ultrasonic retrotips: (a) KiS retrotip, (b) CT-5 retrotip and (c) diamond-coated (DC) retrotip.

Experiment 2

Fifty-five teeth were randomly divided into five groups: three experimental groups of 15 teeth each (for the three different types of retrotips) and two control groups of five teeth each. The root-end cavity in the three experimental groups was prepared by either KiS, CT-5 or DC retrotips. The cavity was dried with air and filled with Super EBA (Harry J. Bosworth Co., Skokie, IL, USA).

In five positive control teeth, the root-end cavity was prepared by the CT-5 retrotip and was not filled with cement. In negative control teeth, the root-end cavity was not prepared.

In the experimental and positive control groups, the root surface was coated twice with nail varnish except the coronal and apical resected surfaces. In the negative control group, all root surfaces including the resected one were coated twice with nail varnish.

Following the method of O'Connor *et al.* (1995), microcentrifuge tubes were attached to the teeth with cyanoacrylate glue. Then, India ink (Salis International, FL, USA) was poured into the tube to a height of 2 cm (Fig. 2).

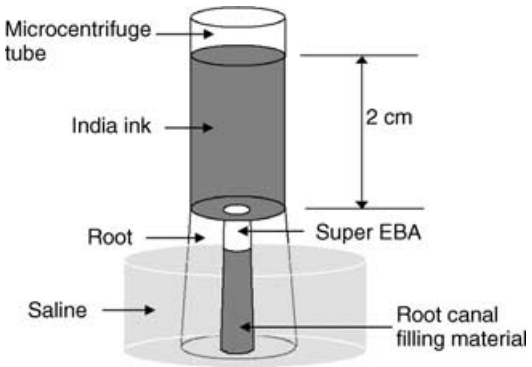

Figure 2 Schematic diagram of experiment 2.

© 2003 Blackwell Publishing Ltd

Table 1 Preparation time (s)

Ultrasonic retrotip	Preparation time (mean ± SD)	
KiS	191.80 ± 42.69	*
CT-5	204.60 ± 53.77	*
Diamond coated (DC)	69.10 ± 9.07	

*Significant difference ($P < 0.01$).

The experimental teeth were wrapped with saline-moistened gauze and stored at 37 °C for 7 days. Each tooth was sectioned longitudinally and maximum dye penetration along the boundary between the filling materials and the dentine wall was evaluated under a microscope. Two specimens in the KiS group were excluded because dye leakage at the boundary between the centrifuge tube and the root was observed. Statistical analyses were performed using the one-way ANOVA and Scheffe's *F*-test as the post hoc test.

Results

Experiment 1

The mean and the standard deviation of the preparation time in each group are shown in Table 1. The DC group required the least time for preparation ($P < 0.01$). The numbers of microcracks produced during preparation were two for the KiS group, one for the CT-5 group, and two for the DC group. There was no significant difference amongst the three experimental groups in the number of dentinal tubule openings on the root-canal wall (Figs 3 and 4).

Experiment 2

The positive controls showed dye penetration throughout the length of the root-end cavity. and the negative

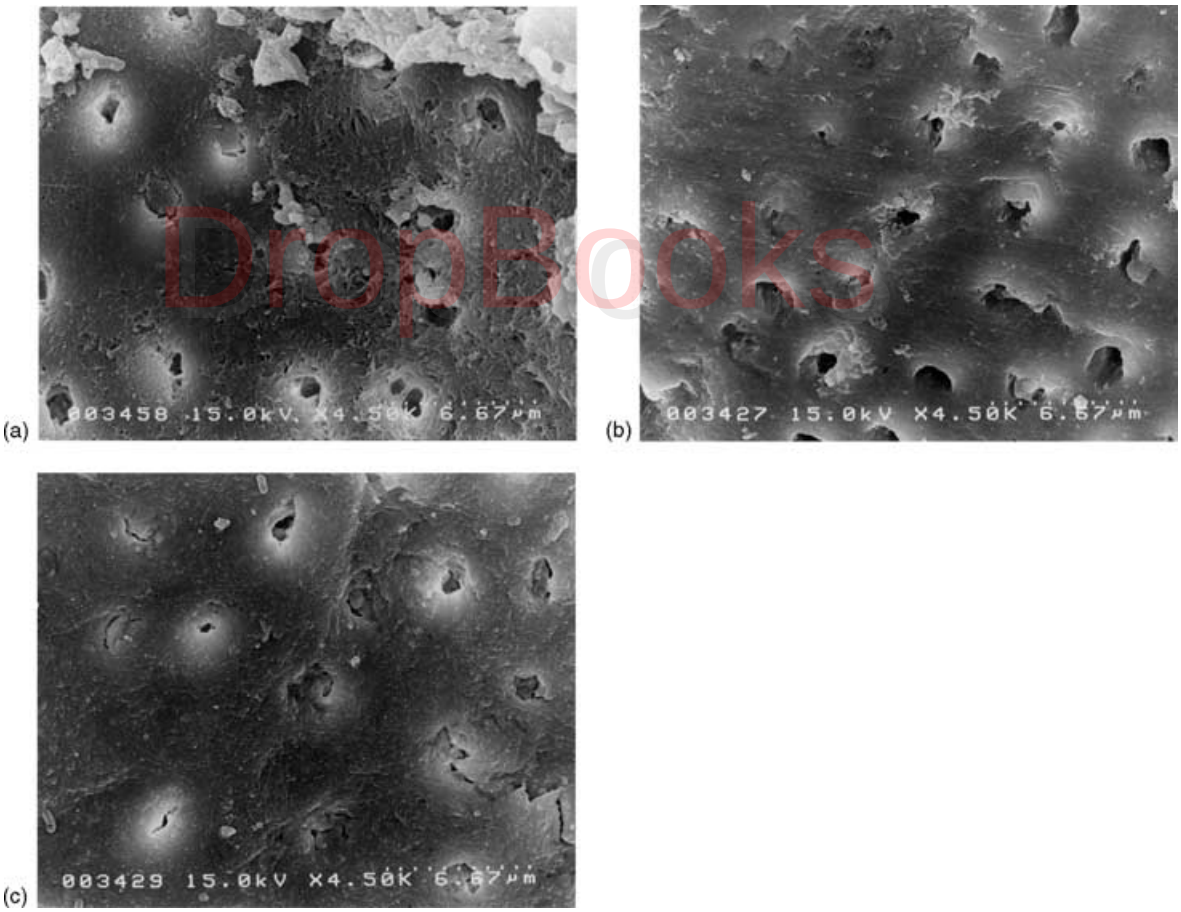

Figure 3 Scanning electron microscope (SEM) photomicrographs of prepared area by three ultrasonic retrotips (original magnification × 4.5 K: (a) KiS, (b) CT-5 and (c) DC).

© 2003 Blackwell Publishing Ltd

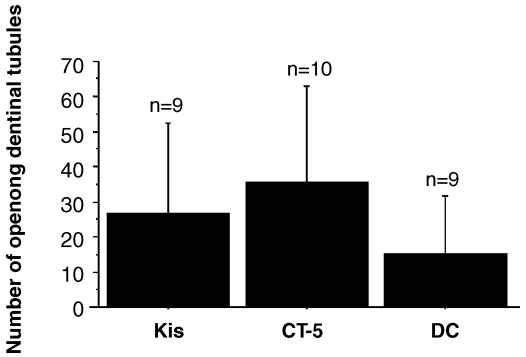

Figure 4 Mean number of dentinal tubule openings on the root-canal wall.

controls showed no dye penetration. The mean distances of dye penetration were 0.30 mm (5 out of 15 showed leakage; however, 2 samples could not be evaluated) for the KiS group, 0.25 mm (9 out of 15 showed leakage) for the CT-5 group and 0.33 mm (5 out of 15 showed leakage) for the DC group. One-way ANOVA and Scheffe's *F*-test as the post hoc test were used to analyse the results, and no significant difference amongst the three groups was found.

Discussion

Ultrasonic retrotips are able to prepare root-end cavities more accurately than the low-speed handpiece (Engel & Steiman 1995). Although it has been reported that the number of microcracks on the resected surfaces increased after preparation with ultrasonic retrotips (Abedi *et al.* 1995, Rainwater *et al.* 2000), few microcracks were created in this study. One explanation for this might be the use of a saline bath during preparation. Manipulation at high power also did not produce a large number of microcracks. Layton *et al.* (1996) reported that root-end cavity preparation using high-power oscillation produced a significant number of microcracks. Conversely, others have reported that the change of oscillation amplitude of the ultrasonic retrotip did not affect the number of microcracks (Waplington *et al.* 1997, Peters *et al.* 2001). Further research is required to determine the optimum power for root-end cavity preparation.

Peters *et al.* (2001) reported that a shorter preparation time was required with DC retrotips than with stainless steel retrotips. The DC retrotip had the shortest preparation time in this study. The preparation time needed with the KiS retrotip coated with zirconium nitride was the same as that needed with the stainless steel retrotips. However, the DC retrotip with efficient cutting ability may cut tooth structure excessively and result in perforation, if the direction of the root-end cavity does not follow the canal. Thus, more careful manipulation may be required when a DC retrotip is used in a clinical situation.

As it was difficult to assess the thickness of smear layer on the prepared canal wall, the number of dentinal tubules opening on the prepared surfaces was evaluated rather than the thickness of smear layer. Ten visual fields per specimen were randomly selected because the number of dentinal tubule openings was diverse. There was no significant difference amongst the three kinds of retrotips in the number of dentinal tubule openings.

Goldman *et al.* (1980) reported that a leakage study using a dye should be performed in a vacuum to exclude the influence of air bubbles. However, O'Connor *et al.* (1995) reported that a dye solution of 2-cm height effectively eliminated the influence of air bubbles; this method was used in the study. There was no significant difference between the three experimental groups with respect to dye leakage.

Conclusion

In this laboratory study, the time to prepare root-end cavities using a KiS zirconium nitride-coated retrotip was the same as that using a conventional stainless steel retrotip, but longer than that using a DC retrotip. There was no significant difference in the number of microcracks or in the penetration of dye in cavities filled with Super EBA cement.

References

Abedi HR, Van Mierlo BL, Wilder-Smith P, Trabinejad M (1995) Effects of ultrasonic root-end cavity preparation on the root apex. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontics* **80**, 207–13.

Engel TK, Steiman HR (1995) Preliminary investigation of ultrasonic root end preparation. *Journal of Endodontics* **21**, 443–5.

Frank RJ, Antrim DD, Bakland LK (1996) Effect of retrograde cavity preparations on root apexes. *Endodontics and Dental Traumatology* **12**, 100–3.

Gilheany P, Figdor D, Tyas MJ (1994) Apical dentin permeability and microleakage associated with root-end resection and retrograde filling. *Journal of Endodontics* **20**, 22–5.

Goldman LB, Goldman M, Kronman JH, Letourneau JM (1980) Adaption and porosity of poly-HEMA in a model system using two microorganisms. *Journal of Endodontics* **6**, 683–6.

© 2003 Blackwell Publishing Ltd

Gorman MC, Steiman HR, Gartner AH (1995) Scanning electron microscopic evaluation of root-end preparation. *Journal of Endodontics* **21**, 113–7.

Layton CA, Marshall JG, Morgan LA, Baumgartner JC (1996) Evaluation of cracks associated with ultrasonic root-end preparation. *Journal of Endodontics* **22**, 157–60.

Lloyd A, Jaunberzins A, Dummer PMH, Bryant S (1996) Root-end cavity preparation using the Micromega Sonic Retro-prep Tip™. SEM analysis. *International Endodontic Journal* **29**, 295–301.

O'Connor RP, Hutter JW, Roahen JO (1995) Leakage of amalgam and Super-EBA root-end fillings using two preparation techniques and surgical microscopy. *Journal of Endodontics* **21**, 74–80.

Peters CL, Peters OA, Barbakow F (2001) An *in vitro* study comparing root-end cavities prepared by diamond-coated and stainless steel ultrasonic retrotips. *International Endodontic Journal* **34**, 142–8.

Rainwater A, Jeansonne BG, Sarkar N (2000) Effect of ultrasonic root-end preparation, microcrack formation and leakage. *Journal of Endodontics* **26**, 72–5.

Saunders WP, Saunders EM, Gutmann JL (1994) Ultrasonic root-end preparation. Part 2. Microleakage of EBA root-end fillings. *International Endodontic Journal* **27**, 325–9.

Sultan M, Pitt Ford TR (1995) Ultrasonic preparation and obturation of root-end cavities. *International Endodontic Journal* **28**, 231–8.

Waplington M, Lumley PJ, Walmsley AD (1997) Incidence of root face alteration after ultrasonic retrograde cavity preparation. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontics* **83**, 387–92.

DropBooks

 © 2003 Blackwell Publishing Ltd